UNIVERSITY OF CALIFORNIA
COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION
BERKELEY, CALIFORNIA

CIRCULAR 343
OCTOBER, 1937

BARLEY AS A FEED FOR HOGS

E. H. HUGHES[1]

BARLEY WAS PROBABLY FIRST GROWN in the Egyptian Sudan. Taken thence to the Mediterranean area, it reached western Europe and finally the North American Continent by various routes. Used in ancient Europe as a food for beast and man, it was the chief bread plant of those nations from which we derive our civilization. According to Hunt[2] barley is successfully cultivated in a wider range of climates than any other cereal. In North America it is grown principally in Canada, in the states along the northern border of the Corn Belt—particularly Wisconsin, Minnesota, North and South Dakota—and in California. Other states, including Nebraska and Iowa, have also produced large quantities of this grain.

It is the purpose of this circular to show the value of barley as a grain concentrate in pork production. The average percentage composition, the digestible nutrients, the total mineral matter, and the calcium and phosphorus content of barley and other similar concentrates are given in table 1.

Western Canadian and middle-western barley contain more protein and a narrower nutritive ratio than barley produced on the Pacific Coast. In comparison with corn (table 1), barley contains more fiber, but less fat and total digestible nutrients. Its protein content and nutritive ratio are, however, similar; and it contains more calcium and phosphorus than corn. In consequence, it is often less efficient than corn when fed to growing and fattening pigs. According to Weaver,[3] when fattening hogs are self-fed with tankage in dry lot, corn produces faster gains on less feed than ground barley. In eight trials at various northern experi-

[1] Professor of Animal Husbandry and Animal Husbandman in the Experiment Station.

[2] Hunt, Thomas F. The cereals in America. 421 p. Orange Judd Co., New York City.

[3] Weaver, L. A. Wheat, oats, barley and rye as hog feeds. Missouri Agr. Exp. Sta. Cir. 261:1–10. 1930.

TABLE 1

AVERAGE PERCENTAGE COMPOSITION, DIGESTIBLE NUTRIENTS, AND MINERAL MATTER, IN BARLEY, CORN, WHEAT, MILO MAIZE, AND RICE*

Feed	Average percentage composition				
	Dry matter	Protein	Fat	Fiber	Nitrogen-free extract
Barley (Pacific states)	89.8	9.5	1.9	6.1	69.6
Corn	88.5	9.7	4.0	2.3	71.1
Milo maize	89.4	11.2	2.9	2.2	71.2
Wheat (Pacific states)	89.1	9.9	2.0	2.7	72.6
Rice (rough)	88.6	8.3	1.8	8.8	64.7

Feed	Digestible nutrients in 100 pounds			Percentage mineral matter		
	Digestible protein	Total digestible nutrients	Nutritive ratio	Total mineral matter	Calcium	Phosphorus
Barley (Pacific states)	7.7	78.5	1:10.2	2.7	0.08	0.36
Corn	7.4	83.7	1:10.3	1.4	0.01	0.28
Milo maize	8.7	79.9	1: 8.2	1.9	....	0.34
Wheat (Pacific states)	8.5	83.6	1: 8.8	1.9	....	....
Rice (rough)	6.3	69.1	1:10.0	5.0	....	0.21

* Data for barley are compilations of analyses from various western experiment stations. Other data are from: Morrison, F. B. Feeds and feeding. 20th ed. 1050 p. The Morrison Publishing Co., Ithaca, New York. 1936.

TABLE 2

GROUND BARLEY COMPARED WITH CORN FOR FATTENING HOGS*

Feed	Average ration	Average daily gain	Feed consumed for 100 pounds of gain	
			Grain	Tankage
	pounds	*pounds*	*pounds*	*pounds*
Barley	6.30	1.44	439	30
Tankage	0.43			
Corn	6.40	1.64	389	39
Tankage	0.64			

* Compiled from averages of results at several northern-states experiment stations.

ment stations, with an average feeding period of 66 days, the results presented in table 2 were obtained.

Ground barley was actually worth about 95 per cent as much as corn in these trials as far as feed required for 100 pounds of gain was concerned. When ground barley and tankage were compared with shelled corn and tankage on pasture, in three other similar tests, the results secured were approximately the same as in the trials first mentioned.

Though shelled corn surpasses barley, either ground or rolled, in the production of pounds of pork, it does not surpass it in the quality of pork produced. Hams, bacon, and other pork products produced largely on barley have a fine reputation on the English, the Canadian, and the Pacific Coast markets. As compared with those grown and fattened on corn, they are thought to be firmer both in the refrigerator room and after being processed; furthermore the percentage of muscle and fat is well balanced.

TABLE 3

Results of Feeding Barley Without Supplement or Pasture

Experiment station	Number of pigs	Average initial weight	Average daily gain	Length of feeding period	Feed consumed for 100 pounds of gain
		pounds	*pounds*	*days*	*pounds*
Wyoming*	5	88.0	1.46	70	413
Oregon†	5	97.0	1.35	75	500
Oregon†	4	85.0	1.30	61	472
Oregon†	6	111.0	1.02	77	524
California‡	10	48.0	0.45	112	562
California§	10	86.0	0.91	70	514
California§	10	123.0	1.30	70	578
Weighted average	..	90.0	1.04	79	523

* Faville, A. D. Swine feeding. I. Barley vs. rye for fattening pigs. II. Barley vs. barley and meat meal for fattening pigs. Wyoming Exp. Sta. Bul. **114**:1-8. 1917.

† Withycombe, James, Ermine L. Potter, and George R. Samson. Experiments in swine feeding. Oregon Agr. Exp. Sta. Bul. **127**:1-30. 1915.

‡ Hughes, E. H. The feeding value of raisins and dairy by-products for growing and fattening swine. California Agr. Exp. Sta. Bul. **440**:1-12. 1927. (Out of print.)

§ Thompson, J. I., and Edwin C. Voorhies. Hog-feeding experiments. Califorina Agr. Exp. Sta. Bul. **342**:371-98. 1922. (Out of print.)

The refractive index of the fat is an excellent measure of its hardness; the lower the refractive index, the harder the fat. Vestal and Shrewsbury[4] reported an average refractive index of 1.4594 for the back fat of the carcasses of 70 hogs fattened on corn and tankage, either in dry lot or on pasture. All were commercially hard carcasses. At the California Station (according to unpublished data) the average refractive index of the back fat from 220 hogs fed barley with tankage, fish meal, or skim milk, either in dry lot or on pasture, was 1.4582.

Tables 3, 4, 5, 6, 7, and 8—the data for which were taken from various sources—show the results of feeding barley alone and with various supplements, with and without pasture, to growing and fattening pigs. Being exceedingly hard, barley should be either ground or rolled before being fed. Grinding or rolling increases its value as a swine feed about 17 per cent.[5] The barley fed in the experiments reported was either ground or rolled.

[4] Vestal, C. M., and C. L. Shrewsbury. The effect of soybeans, soybean oil meal, and tankage on the quality of pork. Indiana Agr. Exp. Sta. Bul. **400**:1–48. 1935.

[5] Morrison, F. B. Feeds and feeding. 20th ed. 1050 p. The Morrison Publishing Company, Ithaca, N. Y. 1936.

TABLE 4

RESULTS OF FEEDING BARLEY AND PASTURE

Experiment station	Number of pigs	Average initial weight	Average daily gain	Length of feeding period	Barley consumed for 100 pounds of gain
		pounds	*pounds*	*days*	*pounds*
California*.....	22	94.2	1.32	84	465
California*.....	12	74.6	1.28	84	393
California*.....	12	100.9	1.22	98	445
South Dakota†.....	8	75.2	1.28	120	474
Weighted average.....	..	88.5	1.28	92	446

* Thompson, J. I., and Edwin C. Voorhies. Hog-feeding experiments. California Agr. Exp. Sta. Bul. **342**:371–98. 1922. (Out of print.)

† Wilson, James W., and Turner Wright. Barley as a fattening feed for cattle and swine in South Dakota. South Dakota Agr. Exp. Sta. Bul. **262**:1–40. 1931.

TABLE 5

RESULTS OF FEEDING BARLEY AND TANKAGE OR FISH MEAL IN DRY LOT

Experiment station	Number of pigs	Average initial weight	Average daily gain	Length of feeding period	Feed consumed for 100 pounds of gain	
					Barley	Tankage or fish meal
		pounds	*pounds*	*days*	*pounds*	*pounds*
Oregon*.....	7	91.0	1.43	61	331	35
Nebraska†.....	35	105.0	1.25	83	486	46
California‡.....	10	112.9	1.37	58	490	28
California‡.....	10	112.2	1.35	58	489	29
California§.....	10	77.5	1.57	70	389	50
California¶.....	10	87.0	1.61	70	425	41
California¶.....	10	60.1	1.34	105	369	45
Ohio‖.....	8	72.3	1.78	79	432	40
Weighted average.....	..	93.9	1.40	76	444	41

* Withycombe, James, Ermine L. Potter, and George R. Samson. Experiments in swine feeding. Oregon Agr. Exp. Sta. Bul. **127**:1–30. 1915.

† Loeffel, Wm. J., Barley as a hog feed. Nebraska Agr. Exp. Sta. Bul. **251**:1–20. 1930.

‡ Thompson, J. I., and Edwin C. Voorhies. Hog-feeding experiments. California Agr. Exp. Sta. Bul. **342**:371–98. 1922. (Out of print.)

§ Hughes, E. H. The feeding value of raisins and dairy by-products for growing and fattening swine. California Agr. Exp. Sta. Bul. **440**:1–12. 1927. (Out of print.)

¶ Hughes, E. H. Rice and rice by-products for fattening swine. California Agr. Exp. Sta. Bul. **420**:1–12. 1927. (Out of print.)

‖ Robison, W. L. Self-feeding swine. Ohio Agr. Exp. Sta. Bul. **355**:19–50. 1922.

TABLE 6

RESULTS OF FEEDING BARLEY AND SKIM MILK IN DRY LOT

Experiment station	Number of pigs	Average initial weight	Average daily gain	Length of feeding period	Feed consumed for 100 pounds of gain	
					Barley	Skim milk
		pounds	*pounds*	*days*	*pounds*	*pounds*
Oregon*	7	126.0	1.86	43	297	213
Oregon*	7	96.0	1.57	61	269	612
California†	6	62.3	1.18	138	352	1073
California†	10	111.8	1.60	58	413	705
California‡	10	54.3	1.61	98	281	842
Weighted average	..	89.7	1.58	78	325	692

* Withycombe, James, Ermine L. Potter, and George R. Samson. Experiments in swine feeding. Oregon Agr. Exp. Sta. Bul. **127**:1–30. 1915.

† Thompson, J. I., and Edwin C. Voorhies. Hog-feeding experiments. California Agr. Exp. Sta. Bul. **342**:371–98. 1922. (Out of print.)

‡ Hughes, E. H. The feeding value of raisins and dairy by-products for growing and fattening swine. California Agr. Exp. Sta. Bul. **440**:1–12. 1927. (Out of print.)

TABLE 7

RESULTS OF FEEDING BARLEY WITH TANKAGE OR FISH MEAL TO HOGS ON ALFALFA, CLOVER, OR RAPE PASTURE

Experiment station	Number of pigs	Average initial weight	Average daily gain	Length of feeding period	Feed consumed for 100 pounds of gain	
					Barley	Tankage or fish meal
		pounds	*pounds*	*days*	*pounds*	*pounds*
Oregon*	10	89.0	1.91	44	337	29
South Dakota†	24	57.1	1.47	112	415	17
California‡	12	73.8	1.39	84	384	28
California‡	12	100.8	1.25	98	442	14
California§	12	83.0	1.66	98	361	24
Weighted average	..	76.4	1.51	93	394	21

* Withycombe, James, Ermine L. Potter, and George R. Samson. Experiments in swine feeding. Oregon Agr. Exp. Sta. Bul. **127**:1–30. 1915.

† Wilson, James W., and Turner Wright. Barley as a fattening feed for cattle and swine in South Dakota. South Dakota Agr. Exp. Sta. Bul. **262**:1–40. 1931.

‡ Thompson, J. I., and Edwin C. Voorhies. Hog-feeding experiments. California Agr. Exp. Sta. Bul. **342**:371–98. 1922. (Out of print.)

§ Hughes, E. H. The feeding value of raisins and dairy by-products for growing and fattening swine. California Agr. Exp. Sta. Bul. **440**:1–12. 1927. (Out of print.)

These tables disclose some interesting and significant facts. A comparison of tables 3 and 4 indicates that the hogs fed barley and pasture have a definite advantage over those fed barley alone, in both rate and economy of gain. When such protein-rich feeds as skim milk, tankage, or fish meal without pasture (tables 5 and 6) are added to the diet, gains are more rapid, and less concentrates are necessary for a unit of increase in weight, than when barley was fed without supplement or pasture. The addition of such protein-rich feeds to barley produced more rapid

TABLE 8

RESULTS OF FEEDING A RESTRICTED RATION OF BARLEY AND SKIM MILK TO HOGS ON PASTURE*

Trial No.	Number of pigs	Average initial weight	Average daily gain	Length of feeding period	Feed consumed for 100 pounds of gain	
					Barley	Skim milk
		pounds	*pounds*	*days*	*pounds*	*pounds*
1	31	50.1	0.92	166	275	823
2	20	53.0	0.95	154	285	853
3	30	51.0	0.94	154	283	848
4	38	43.0	0.97	140	279	836
Weighted average	..	48.5	0.95	153	280	838

* Unpublished data from the California Agricultural Experiment Station.

gains than when barley was fed and the pigs had free access to green pasture. Apparently the barley proteins and those secured from the pasturage were not sufficient to permit rapid gains. When young growing pigs were given barley and tankage or fish meal, with free access to green alfalfa, clover, or rape pasture, there was a marked saving in concentrates necessary to produce 100 pounds of gain as compared with results obtained by feeding the same rations without pasture (tables 5 and 7). The pasture actually saved an average of 50 pounds of barley and 20 pounds of tankage or fish meal for each 100 pounds of live hog produced. In general the same was true for hogs fed barley and skm milk with or without pasture (tables 6 and 8). Since, unfortunately, the results reported for barley and skim milk with access to pasture were for hogs fed a limited grain ration, no comparison for the rate of gain is possible. Significantly, on a dry-matter basis either with or without pasture, it required less barley and skim milk than it did barley and tankage or fish meal to produce a unit of gain.

To compare the value of barley with that of other concentrates available, table 9 is presented. These results are averages compiled from various sources in an effort to show clearly and definitely the respective values of these concentrates when supplemented with the same nitrogenous concentrate.

Because of these and other facts concerning barley, a critical examination of that grain as a hog feed was begun by the California Agricultural Experiment Station in 1926. This study has shown that barley, when fed alone to young pigs, does not contain enough vitamin D or calcium for normal skeletal growth. Fed along to young pigs after weaning, in either the presence or the absence of direct rays of the sun, it results in death in about 200 days on an average. Because of its low calcium content or the lack of proper balance between its calcium and phosphorus, when fed

TABLE 9

AVERAGE RESULTS OF FEEDING TESTS WHERE VARIOUS GRAIN CONCENTRATES WERE FED WITH TANKAGE OR FISH MEAL IN DRY LOT

Ration	Number of pigs	Average initial weight	Average daily gain	Feed consumed for 100 pounds of gain
		pounds	*pounds*	*pounds*
Barley and tankage or fish meal*	100	93.9	1.40	Barley 444; tankage 41
Corn and tankage or fish meal†	98	82.4	1.37	Corn 392; tankage 34
Wheat and tankage or fish meal‡	33	90.4	1.55	Wheat 377; tankage 34
Kafir or milo and tankage or fish meal§	31	89.1	1.29	Kafir or milo 454; tankage 28
Rough rice and tankage or fish meal (ground fine)¶	24	80.5	1.40	Rice 457; tankage 56

* Averages compiled from publications of Nebraska, Ohio, and California experiment stations.
† Averages compiled from publications of Missouri, Nebraska, Texas, and Ohio experiment stations.
‡ Averages compiled from publications of Missouri, Nebraska, and Texas experiment stations.
§ Averages compiled from publications of Oklahoma and California experiment stations.
¶ From: Hughes, E. H. Rice and rice by-products for fattening swine. California Agr. Exp. Sta. Bul. 420:1–12. 1927. (Out of print.)

without supplement over a long period of time to mature hogs, particularly gestating and lactating sows, it causes lowering of the blood calcium.[6]

Barley has less than one-sixth of the vitamin-A[7] content of yellow corn. A lack of reproduction results when it is fed as the only source of vitamin A to young growing gilts.[8] Other results of this deficiency of barley are night blindness, peculiar gaits, and crooked spines. Barley proteins, in the amount found in California barley, have been definitely shown to be inadequate for rapid or optimum growth in the pig. As this station has recently demonstrated, the pig requires some of the factors in the vitamin-B complex. Since most of our barley is probably low in vitamin-G content, it should be supplemented with some feed that contains this factor in appreciable quantities.

Barley, like other cereal grains, needs to be supplemented with other

[6] Hughes, E. H., and Hugh Hart. Calcium and phosphorus content of the blood of pigs. Amer. Soc. Anim. Prod. Proc. 1931:274–77. 1932.
[7] Hughes, E. H. Vitamin A content of barley. Jour. Agr. Research 47:487–94. 1933.
[8] Hughes, E. H. Some effects of vitamin-A-deficient diets on reproduction of sows. Jour. Agr. Research 49:943–53. 1934.

food elements if normal growth, reproduction, and physical well-being are to be expected. Fortunately such supplementary concentrates as skim milk, tankage, or fish meal and green legume pastures supply those food elements or accessory factors that are deficient in barley.

Unless such supplementary feeds are provided generously, however, the addition of 1 per cent salt and 1 per cent of lime in the form of

TABLE 10

EFFECT OF SUPPLEMENTING AN APPARENTLY GOOD RATION WITH PASTURE*

Lot No.	Ration	Beginning weight	Average daily gain	Feed consumed for 100 pounds of gain
		pounds	*pounds*	*pounds*
1	Barley 88 per cent Tankage 7 per cent Linseed meal 3 per cent Salt 1 per cent Calcium carbonate 1 per cent Pasture at will, except for 4 hours biweekly	58.3	1.22	445
2	Barley 88 per cent Tankage 7 per cent Linseed meal 3 per cent Salt 1 per cent Calcium carbonate 1 per cent Pasture only 4 hours biweekly	57.6	1.00	472

* Unpublished data from California Agricultural Experiment Station.

ground limestone, air-slacked lime, or oyster-shell flour will be advantageous. Under normal conditions no other minerals are necessary.

For growing and fattening pigs, gestating and lactating sows, ground or rolled barley should be supplemented with skim milk, buttermilk, or other dairy by-products, tankage, fish meal, linseed oil meal, soybean meal,wheat middlings, or combinations of these in addition to green pasture. If pasture is not available, green leafy alfalfa or other legume hay should be supplied. Table 10 shows the value of pasture for growing pigs fed what seemed to be a good ration.

This table gives the results of two experiments with 35 pigs in lot 1 and 36 pigs in lot 2. All the pigs in these tests were grown normally and had free access to green pasture before being placed on the experiments. The pigs in lot 2 were given access to pasture 4 hours every other week, to protect them from vitamin-A deficiency. Even though the diet seemed adequate these pigs failed to gain as rapidly as those in lot 1, which had free access to pasture except for 4 hours biweekly; and they required more feed for 100 pounds of gain. The pigs in lot 1 got from the pasture something other than vitamin A that resulted in increased food consumption and therefore in more rapid gains.

12*m*-10,'37(118)